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XIV.—*Explorations through the Valley of the Atrato to the Pacific, in Search of a Route for a Ship Canal.*

By direction of F. M. KELLEY, Esq., of New York.

Communicated by the SECRETARY.

*Read, April 28, 1856.*

IN treating on the various facilities for connecting the Atlantic and Pacific Ocean, by a canal through the Great American Isthmus, Baron Humboldt drew attention nearly fifty years since, to the course of the Atrato and its tributaries, and to the depressions said to exist in the range of mountains between that river and the Pacific.

The growth of commerce in the Pacific, since the discovery of gold in California and Australia, has produced a large traffic both of passengers and goods across the Isthmus; leading to the formation of the Panama Railway, and to an active use of the waters of Lake Nicaragua and its outlet, the river San Juan del Nicaragua. Surveys have been effected at Tehuantepec, and from the Gulf of Honduras to Fonseca Bay. An endeavour, supported by the governments of Great Britain, France, and the United States, was also made to survey the Isthmus between Caledonia Bay and the Gulf of St. Miguel. In the papers of Captain Robert FitzRoy, printed in the Journals of this Society, other routes are described or proposed, but it is unnecessary to add further to this general view of the subject, than to observe that none of them have presented facilities warranting the construction of that great desideratum, a navigable passage between the two oceans.

No material additions to our knowledge of the Atrato River had been made, since Baron Humboldt drew attention to it, until the year 1852. In that year, Mr. Kelley of New York, impressed by Baron Humboldt's reports in favour of the Atrato, resolved on causing a survey of that river to be made, including the routes between it and the Pacific, for the purpose of determining whether a ship canal could be constructed in that quarter.

At the expense of Mr. Kelley and other gentlemen, a surveying party, equipped with proper instruments, was despatched to the Atrato, under the direction of Mr. J. C. Trautwine, a civil engineer of Philadelphia, who had previously been engaged in superintending the formation of the Panama Railway.

Mr. Trautwine surveyed the mouths of the Atrato and the course of the river to Quibdo, where the Atrato is joined from the west by the River Quito. During his ascent of the river, Mr. Trautwine also partially examined several of its tributaries as he arrived at their mouths.

Above Quibdo, Mr. Trautwine directed his attention in the first place to the River Quito and its tributary the Pato; and having ascended the Pato to its source, he crossed the dividing ridge to the River Baudo, which he descended to its mouth on the Pacific. Returning from thence to Quibdo, he retraced his steps along the Baudo, as far as its confluence with the Pápé. Here he changed his route, by ascending that river to its source, crossing the dividing ridge to the River Surucco, one of the head waters of the San Juan, and proceeding along the last named river to Quibdo. In proceeding from the San Juan to Quibdo, he crossed the water parting, said to be intersected by the Raspadura Canal. But no such work was known in the neighbourhood, and the passage to Quibdo, from San Pablo on the San Juan, across this ridge, which divides the waters of the Atlantic from those of the Pacific, follows the course of the Santa Monica, the San Pablo, and the Quito; names by which the western branch of the Atrato is designated at successive portions of its course. This route was again traversed by Mr. Trautwine, in a journey from Quibdo along the San Juan, to its mouths at Chirambira, on the Pacific, from whence he proceeded to the adjacent anchorage of Buena Ventura, and returned home by way of Panama, in the month of September, 1852, having entered the Atrato in June. During this journey, astronomical observations for latitude were made as often as the usually obscured state of the heavens would allow. Altitudes were taken by the spirit level and barometer, the width of the river by angles from a measured base, and distances along the streams by repeated observations of the rate of the boat's passage. The depth of the streams, velocity of the current, and rise and fall of the water, were also observed; and generally whatever could contribute to a knowledge of the country, and the specific object of the expedition.

In 1853, two parties were despatched at the sole expense of Mr. Kelley, under Mr. Porter and Mr. J. C. Lane, civil engineers of New York, for the purpose of following up Mr. Trautwine's labours. Mr. Porter's investigation extended, along the Atrato and Quito, to San Pablo on the San Juan; the route previously taken by Mr. Trautwine, whose observations were fully confirmed by the levels and surveys of his successor. Mr. Lane also examined the Atrato to Quibdo, and from thence took the eastern route along the Atrato to the Andágueda, from whence he crossed the dividing ridge to the San Juan, and declared it to be impracticable. Mr. Lane also examined the Raspadura, and confirmed by his own observation the reports previously given by the inhabitants to Mr. Trautwine.

These expeditions, well supplied with instruments, furnished ample information concerning the Atrato from its mouths to its

head-waters, and across the intervening summits to the rivers Baudo and San Juan.

The Atrato falls into the Gulf of Darien through nine mouths called "bocas" or "caños" intersecting an extensive swamp. They are named from west to east, Taréna, Candelária, Páva, Matuntúbo, Coquíto, Coco grande, Pántano, Urabá, and Piguindé. Bocas Tareno and Matuntubo discharge much larger volumes of water than any of the others; but the Boca Coquíto appears to offer superior facilities for improving the navigation.

For 96 m. above the Boca Coquíto, measured by the windings of the river, the width of the Atrato is generally between 750 and 1000 ft. Throughout this distance, the channel is also sufficiently deep for the largest ocean steamers and sailing vessels. At the River Sucio, 61 m. above Boca Coquíto, the width is 1050 ft., with a low water channel of 50 ft. in depth. Seventy-five m. above Boca Coquíto the width is 950 ft., and the depth 45 ft. In many intermediate spots, soundings were taken at 60 to 75 ft. It must be remarked that the river was lower at this time than it had been for 20 years. The ordinary height of the water is indicated by a line along the banks, below which no grass grows, and this line was 3 to 4 feet above the water, near the confluence of the Napipi.

It was generally impossible to measure base lines on shore for determining the width of the river, on account of the soft mud and dense vegetation, as well as the detention of the boat laden with merchandize. On this account, the length of the boat, 68 ft., was taken as a base line; and at every stoppage for meals or other purposes, Mr. Trautwine and his assistants took simultaneous angles from each end of the boat to some well-defined object on the banks. The instruments were graduated to minutes, and errors are estimated to be within 10 or 20 ft. Whenever it was practicable, base lines were measured on shore.

Opposite Quibdo, at a distance of 220 m. above the Caño Coquíto, the Atrato is 850 ft. wide, with a current varying from  $2\frac{1}{2}$  to 3 m. per hour, and a depth varying from 8 to 20 ft. The fall of the river from Quibdo to the sea is less than 3 in. to a m. Steam navigation might be extended as far as the confluence of the San Pablo and Certigui, 32 m. above Quibdo. Twenty-one m. above the mouth of the Certigui is the confluence of the Raspadura and Monica, which unite to form the San Pablo. At this point the navigation is limited to a boat channel of 10 to 20 ft. in width, and usually 3 to 4 ft. in depth.

The Raspadura was reported to Baron Humboldt, as having been made into a canal by the curate of Novita in 1788; but it proves to be an inferior stream to the Monica, and the recollection of any such work does not exist in the neighbourhood. It is quite probable that a curate interested in the boating-business, may

have exercised sufficient influence over some of the gold-hunting members of his flock, to induce them to cut down a few bushes, and to hollow out a short gutter, between two streams flowing in contrary directions from the summit. Such a ditch may have been used as part of a canoe-slide from one stream to the other; and precisely the same kind of canal could now be made, by a dozen expert labourers, in a few days.

The Raspadura has been abandoned by travellers for some years, and is superseded by the Santa Monica. Along the latter stream, the line of levels showed the lowest summits between the Atrato and the San Juan, to be 183 ft. above the San Juan at San Pablo, and 80 ft. above the head of the canoe navigation on the Monica.

The width of the San Juan at San Pablo is 450 ft., the depth 5 ft., and the current, 3 miles per hour. The length of the river from San Pablo to the Pacific at Chirambira is 123 miles. It receives several tributaries which are named in Mr. Trautwine's map, contains several islands, and terminates in a sandy bay, through a swampy delta.

The dividing ridge between the Pato and the Baudo offered still less inducements for a ship canal, the summit being at least 700 ft. above the Pato; while the descent to the Baudo was extremely precipitous, passing for about a m. along a path varying in breadth from 2 to 8 ft., with vertical precipices on each side, descending to a depth of from 50, to more than 200 ft. These precipices consisted of clay and gravel; but they support a vegetation not only of grass and shrubs, but also of full sized trees, and their permanence can only be due to the absence of frost.

The Baudo proved to be navigable, with an average breadth of 200 ft., but terminating in a bay which is only 4 to 9 ft. deep over its whole area.

This examination of the heads of the Atrato, and of the dividing ridge separating its waters from those flowing into the Pacific, as well as the unfavourable nature of the latter, dispelled the prospect of a ship canal in that direction, and limited further inquiry to the lower parts of the river.

During Mr. Lane's sojourn in Quibdo, his attention was directed to the River Truando, by some Indians who had arrived at Quibdo from the Pacific, by that route. His consequent preliminary examination of that river, proved to be so favourable, that another expedition for accomplishing its survey was resolved on.

In the year 1854, Mr. Lane was therefore despatched by Mr. Kelley, with four assistants provided with instruments and a full equipment, to examine the Truando. He ascended as far as Townsend junction, 38 m. from the confluence, and reported the Truando to be 150 ft. wide, and 15 ft. deep up to that point, and

flowing through swamps. A fever contracted at Aspinwall on the way out, prevented him from pushing through to the Pacific.

In November, 1854, another expedition under Mr. William Kennish, accompanied by Mr. Norman Rude and Dr. R. G. Jameson, was despatched by Mr. Kelley, with instructions to commence operations from the side of the Pacific. The coast was to be followed from Panama Bay, southward as far as the latitude of the Truando in  $7^{\circ}$  N.; with a view to the discovery of a harbour, and of any depressions in the range of the Cordillera, which would admit of an open cut, without locks, between the two oceans. Observations presenting any prospect of such a result, were to be followed by a thorough survey; for which the proper instruments and means were provided.

Mr. Kennish penetrated Darien Harbour as far as Chapigana, where he obtained the assistance of Mr. Nelson, who resides there, and of a pilot acquainted with the coast. Another pilot was also engaged at Garachine. Behind the village of Garachine, the mountains rise to the height of 3000 ft. and pass southward, following the coast to Puerto Pinas, where their elevation is but little diminished. The mountains are covered with dense forests, from the margin of the sea to the highest visible part of the range. No harbour for large vessels occurs southward from Garachine Point, until Puerto Pinas is reached. This harbour is  $2\frac{1}{2}$  m. wide at the mouth, and extends inland for 5 m. It is closely hemmed in by mountains, densely wooded, and rising to the height of 500 to 1000 ft. The more distant ranges in the interior appear to rise above 3000 ft. A steep hill was ascended with great difficulty, and its altitude observed to be nearly 500 ft. The foliage rendered it impossible to obtain a prospect beyond a few yards, and this difficulty occurred throughout the route.

The coast between Puerto Pinas and Punto Ardita is bold and rocky. There are two remarkable promontories—the northerly is called Punto Muerto, the southern is Punto Caracoles. In the vicinity of these points the small coasting vessels find anchorage. Punto Cocalito is another similar promontory, about 6 m. from Punto Ardita. At Punto Ardita, commences the bay which receives the Yurador and Paracuchichi rivers and others of less note. Here also a remarkable depression of the Cordillera, from altitudes of thousands of feet to only a few hundreds, presented a feature which it was determined to explore. The bay is bounded on the s. by the remarkable promontory of Cape Marzo, distant 35 m. from its northern limit at Punto Ardita. The depth of the bay, from a line connecting the two headlands, is 15 m. The coast-line is formed by three great playas or sandy beaches: the first of which, forming a segment of a circle, extends from Punto Ardita to the mouths of the Yurador; the second continues in a

straight line from the Yurador to the Paracuchichi, a distance of 10 m.; the third extends, in a semicircular form, to the mouth of the Corredor River, a distance of 15 m.

The waves of the Pacific break in long continuous lines of surf against these elongated beaches, from whence the water deepens very regularly and gradually, affording anchorage in 10 to 30 fathoms, on a sandy bottom, within 2 or 3 m. of the shore.

Off the points of Ardita, Yurador, and Marzo, there are detached rocks, but all other parts of the bay are free from obstruction.

At Corredor, an indentation of the coast forms a safe anchorage and harbour, where large ships can find protection from nearly every wind, within a distance of 7 or 8 m. from the mouth of the Paracuchichi.

After an unsuccessful attempt to enter the Yurador, the party landed at Corredor, from whence, with the aid of a resident pilot, a bongo was navigated through the surf into the Paracuchichi. From the mouth of this river a spacious inlet was found extending northwards like a fine inland lake, with a perfectly smooth surface, 4 miles in length, and 250 to 500 yards in breadth at low water. The peninsula which separates it from the ocean is so densely covered with cocoa-nut palms and other tropical vegetation that it can only be traversed by beaten tracks. It is about 10 miles long and 300 to 500 yards broad. On the mainland the inlet is bordered by mangrove, distinguished by the extreme hardness and durability of its wood, and suitable for piles.

The inlet is not laid down on any chart. It is situated in  $6^{\circ} 57' 32''$  north latitude. The temperature was cool and agreeable. The thermometer ranged from  $84^{\circ}$  at noon to  $70^{\circ}$  at night, and the aneroid barometer from 29.35 to 29.42.

Towards the north the inlet narrows. During high tide canoes can pass to the southern mouth of the Yurador, but at low water a mudbank connects the peninsula with the main. The highest tide observed at Paracuchichi, at spring and neap, was 12 ft. 6 inches, and the lowest, 10 ft. 11 inches. The surface of the peninsula is several feet above the highest tide, and the inhabitants have no recollection of its having been inundated.

The peninsula thus forms a permanent breakwater, sheltering a beautiful and tranquil inlet, almost adapted by nature to serve as a dock or harbour, and suitable in every respect for the terminus of a canal.

Violent storms are almost unknown in this part of the Pacific. The line of surf extends outwards about 100 yards. It is a common feature in the Pacific, and is more formidable in appearance than in reality, especially on a bottom of sloping sand. A boat can pass through it safely.

The capabilities of the Kelley-inlet, the existence of good anchorage in the offing, and the harbour at Corredor in the vicinity, concurring with the extreme rarity of storms on this coast, tended materially to encourage the prospects offered by the great depression in the Cordillera, and to justify the exploration of a route from this point to the Atrato.

Accompanied by some natives, the party entered the small river Mary, up which the tide ascends for 2 miles, when it becomes quite shallow. A mile and a quarter beyond the tidal reach, it receives a small tributary from the north-east, along which the route proceeded to a spot called "Dos Bocas," at the junction of another stream. Passing over a hill between the streams, the party came to the Chupipi, a tributary of the Paracuchichi, flowing from n. to s. After crossing a succession of clay hills, the Chuparador was reached, flowing also into the Paracuchichi. A short distance beyond, the last stream flowing into the Pacific was observed, and, crossing the summit at a height of 540 feet, the Hingador was found, descending over a series of falls to the Nerqua, a tributary of the Truando. The distance of the summit from the Pacific is 10 m. and 750 yards. The Nerqua was descended in boats to its confluence with the Truando, along which the party proceeded to the Atrato. After ascending the Atrato to Quibdo, Mr. Kennish returned to the Truando, and pursued its survey from its mouth to the Gulf of Darien. The map and section deposited with the Society show the course of the Truando, together with the route through the depression of the Cordillera, according to the survey and levels made by Mr. Kennish.

Mr. Kennish proposes to enter the Atrato by the Caño Coquito. The greatest depth on the bar is about 4 ft. at low water; the soundings gradually deepen, and become 30 ft. within 2 miles, when the depth increases to 47 feet, and is nowhere less up to the Truando. The width varies from a quarter of a mile to 2 miles, and the removal of the bar would allow of the transit of the largest steamers. The confluence of the Truando is about 63 m. from the Gulf, and that river forms the channel of the proposed line for 36 miles. The line then follows the valley of the Nerqua through rock-cutting, and passes the summit by a tunnel of  $3\frac{1}{4}$  miles. It reaches the Pacific through the valley of a small stream, and débouches at Kelley-Inlet.

In the valley of the Atrato, 300 miles long and 75 broad, and lying between the Antiochian mountains on the e. and the Cordillera of the Andes on the w., rain falls almost daily; which accounts for the immense supply of water in that region. On the Pacific side of the Cordillera there is scarcely any rain for eight months of the year.



The greater portion of the rain falling in the Atrato valley, is caught above the confluence of the Truando. Fifteen large tributaries and numerous smaller streams fall into the Atrato and contribute to the immense lagoons, which form natural reservoirs and a superabundant store of water throughout the year.

There are various cogent reasons for selecting the confluence of the Truando as the best point from whence the passage from the Atrato to the Pacific may be effected.

In the first place, there is no point of junction with the Atrato by western tributaries, so near the level of high water on the Pacific as that of the Truando. It happens to be 9 feet above the Pacific at high water, and it is therefore of sufficient elevation to prevent the Pacific at high water from flowing through the proposed cut into the Atrato; while it is not so high as to cause the current from the Atrato to the Pacific at *low* water to pass through the cut too rapidly. In fact the elevation of the Truando confluence just preserves a preponderating balance on the side of the Atrato.

The Atrato, at the junction of the Salaqui, is only one foot above the level of the Pacific at high water; but the dividing ridge is 1063 feet high and 30 miles wide, according to a survey of that route by Mr. Kennish and Mr. Nelson.

Should any of the rivers at the mouth of the Atrato be selected, without reference to the height and width of the dividing ridge, it may be observed that the maximum tidal wave in the Pacific being 25 feet and that on the Atlantic only 2 feet, the Pacific at high tide would flow into the Atlantic with a current equal to a head of  $11\frac{1}{2}$  feet; and at low water in the Pacific, the Atlantic would flow into it with a similar current. In the inlet of the Gulf of Miguel, recently called Darien Harbour, the action of the tide is so strong, that H.B.M. steamship 'Virago,' commanded by Captain Prevost, dragged both anchors ahead, and was only brought up by paying out nearly all her cable.

The height of the tides and the levels of the two oceans have been well established by the recent observations of Colonel Totten in Navy Bay on the Atlantic, and in a deep bend of the Bay of Panama on the Pacific. On the Atlantic, a consecutive series of 32 observations was taken in the months of August and September, during the season of calms. On the Pacific, two sets of observations were made. The first, during May and June, when 54 consecutive tides were observed in a season of calms; and the second in November and December, when 52 consecutive tides were observed in a season of light winds. The results of these observations, which do not exactly correspond, are given in the following table:—

	PACIFIC.		ATLANTIC.
	May and June.	Nov. and Dec.	Aug. and Sept.
Greatest rise of tide .. .. .	17·72	21·30	1·60
Least .. .. .	7·94	9·70	0·63
Average .. .. .	12·08	14·10	1·16
Mean tide of Pacific above mean tide of Atlantic .. .. .	0·759	0·140	
High spring tide of Pacific above high spring tide of Atlantic .. .. .	9·40	10·12	
Low spring tide of Pacific <i>below</i> low spring tide of Atlantic .. .. .	6·55	9·40	
Mean high tide of Pacific above mean high tide of Atlantic .. .. .	6·25	6·73	
Mean low tide of Pacific <i>below</i> mean low tide of Atlantic .. .. .	4·73	5·26	
Average rise of spring tides .. .. .	14·08	17·30	
Average rise of neap tides .. .. .	9 60	12·40	

These observations make the mean level of the Pacific from 0·14 to 0·75 higher than the mean level of the Atlantic, but this is probably owing only to local circumstances, and it may be assumed that there is no difference in the mean levels of the two oceans.

The conclusions arrived at by the successive independent surveys carried out at the expense of Mr. Kelley, may be summed up as follows :—

*First*—That the oceans can be united through the Atrato and Truando by a canal without a lock or any other impediment.

*Second*—That while the distance between the oceans by this route is only 131 m., half that distance is provided by nature, with a passage for the largest ships.

*Third*—The remaining distance requires the removal of bars, excavations, and cuttings, presenting no unusual difficulties.

*Fourth*—Harbours requiring but little improvement to render them excellent, exist at the termini.

These investigations have been carried thus far at the expense and through the untiring perseverance of private enterprise.

The capabilities which have been brought to light appear to be of a nature to warrant a special inquiry, of an authorized and international character, both in the direction pointed out by these successive and independent surveys, and wherever the nature of the coast would justify an examination of the interior.

To this point the attention of the great maritime governments of Great Britain, France, and the United States is now being directed, and it is hoped that the proposal to extend and certify the geographical knowledge of the narrow strip of land which divides the two great oceans, by means of governmental investigation, will be considered deserving of the support of the Royal Geographical Society.